Back-Light Module for Image Scanning Device and Method for Calibrating Illumination with the Back-Light Module

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally relates to a back-light module of image scanning devices for transmissive original documents, and in particular to a method for calibration of illumination in order to obtain a substantially uniform illumination over an original document.

2. Description of the Prior Art

Document scanners are generally classified in two types for respectively handling a reflective original document which comprises an opaque substrate and a transmissive original document which comprises a transparent substrate. A transmissive original document scanner comprises a back-light module for generating light projecting the image formed on an original onto an image sensor system of the document scanner.

A conventional back-light module comprises a movable line-type light source which is moved in a given direction from one end of the original document to an opposite end. A driving system is required to move the light source which complicates the overall structure of the back-light module.

Another conventional back-light module comprises a surface-type light source which requires no movement of any parts of the back-light module. Figure 1 of the attached drawings shows an image scanning device having a back-light module comprising a surface-type light source and Figure 2 shows an exploded view of the back-light module.

As shown in Figure 1, a conventional scanner for transmissive original documents, designated with reference numeral 1, comprises a housing (not labeled) having a transparent document supporting plate 10 for supporting an original document (not shown) containing an original and a back-light

module 3 in the form of a flip cover for selectively covering the document supporting plate 10. An optical scanning module 11 comprising a sensor system is movably supported inside the housing by guide rails 12, 13 for moving in a longitudinal direction (Y direction) under the control of a control unit 14. The sensor system comprises a line of sensing elements, such as an array of CCD (Charge Coupling Device), arranged in a lateral direction (X direction) onto which a "scan line" of the original is projected by light generated by the back-light module 3. The sensing elements convert the optical signal caused by the scan line into electrical representation of the scan line. By moving the optical scanning module in the longitudinal direction line by line or step by step and scanning the original one scan line at a time, the original or a portion of the original document may be scanned.

As shown in Figure 2, the back-light module 3 comprises a casing 31 having an open bottom closed by a bottom plate 32. An opening 32a is defined in a central area of the bottom plate 32 receiving and retaining a transparent plate 37. Two tubular lamps 41, 42, such as cold cathode fluorescent lamps, are arranged inside the casing 31 and spaced from each other with a light guide plate 34 disposed therebetween. Two diffusion boards 35, 36 are arranged between the light guide plate 34 and the transparent plate 37. Light from the tubular lamps 41, 42 are guided by the light guide plate 34 for spreading over and projecting from the light guide plate 34 onto the diffusion boards 35, 36. The light is further distributed by the diffusion boards 35, 36 to uniformly project toward and through the transparent plate 37. A reflective sheet 33 is arranged between the light guide plate 34 and a top of the casing 31 for directing light back to the transparent plate 37.

Since uniform distribution of light is required in obtaining good result of scanning transparent original documents, the diffusion boards 35, 36 are important parts for the conventional scanner. Although an illumination calibration zone 2 extending in the direction of the CCD array, namely the X direction (or the lateral direction as defined above), for calibration of illumination of the back-light source, there is no way in the conventional design to calibrate illumination in the Y direction (or the longitudinal

direction as defined above). Uniformity of illumination in the Y direction is in generally achieved by the diffusion boards 35, 36. However, using diffusion boards to uniformly distribute light complicates the overall structure of the back-light module and increases costs.

Thus, it is desired to provide a back-light module of an image scanning device for overcoming the above discussed problems.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide a back-light module of an image scanning device having a simple structure and thus low costs.

Another object of the present invention is to provide a method for operating the back-light module to achieve an excellent scanning result of a transparent original document.

According to the present invention, a back-light module of an image scanning device comprises a casing having an open bottom, a pair of tubular lamps mounted inside the casing with a light guide plate arranged between the lamps and a frosted transparent plate attached to the open bottom of the casing. The image scanning device includes a document supporting plate for supporting a transmissive original document and an optical scanning module containing sensing elements arranged in a line in a lateral direction and movable in a longitudinal direction in a scan line by scan line fashion. The back-light module is selectively positioned on the document supporting plate with the frosted plate facing the document. Light is projected from the back-light module through the document and toward the sensing elements. The frosted plate functions to more uniformly distribute the light over the document supporting plate.

A method for calibrating illumination of a surface type back-light source is also provided in the present invention. The calibration of illumination is done by (1) activating the back-light module to project light onto the sensing elements, (2) driving the optical scanning module in the longitudinal direction, (3) obtaining illumination signals associated with

selected pixels of a longitudinally-extending calibration zone formed on the document supporting plate, (4) comparing each illumination signal with a reference to obtain a result and manipulating the result to obtain a calibration parameter, and (5) calibrating illumination of pixels of an image with the corresponding calibration parameters in scanning a transmissive original document on which the image is formed to obtain an excellent scanning result of the document.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be apparent to those skilled in the art by reading the following description of a preferred embodiment and the best mode of operation thereof with reference to the attached drawings, in which:

Figure 1 is a perspective view of a conventional flat bed image scanning device having a back-light module thereon;

Figure 2 is an exploded view of the back-light module of the conventional image scanning device of Figure 1;

Figure 3 is an exploded view of a back-light module constructed in accordance with the present invention;

Figure 4 is a perspective view of an image scanning device constructed in accordance with the present invention; and

Figure 5 is a flow chart of a method for calibrating illumination of the back-light module of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to the drawings and in particular to Figure 3, a back-light module constructed in accordance with the present invention, generally designated with reference numeral 3', is shown. It is to be noted that, for simplicity, similar elements through the drawings will be designated with same or like reference numerals.

The back-light module 3' comprises a casing 31 inside which two spaced tubular lamps 41, 42, such as cold cathode fluorescent lamps. A

light guide plate 34 is arranged between the tubular lamps 41, 42. A reflective sheet 33 is located between the light guide plate 34 and the casing 31. A frosted light-transmissive plate 38, such as a frosted transparent acrylic board, is attached to a bottom opening (not labeled) of the casing 31 opposing the light guide plate 34 for distributing light from the light guide plate 34. The frosted light-transmissive plate 38 also protects the light guide plate 34 and prevents debris and other contamination from entering the casing 31.

Figure 4 shows an image scanning device, generally designated with reference numeral 1, incorporating the back-light module 3' of the present invention. The image scanning device 1 comprises a housing having a top surface, providing a document supporting plate 10. The back-light module 3' is pivotally attached to the housing for selectively positioning on the document supporting plate 10 or covering an original document placed on the document supporting plate 10. A pair of guide rails 12, 13 extending in a longitudinal direction (Y direction) is arranged inside the image scanning device for movably supporting an optical scanning module 11 whereby the optical scanning module 11 is controlled by a control unit 14 to move in the longitudinal direction Y.

The image scanning device 1 comprises a line of image sensing elements (not shown), such as a CCD array, extending in a lateral direction (X direction) for detecting a scan line of the original document when light is generated by and projected from the back-light module 3', through the transmissive original document, onto the optical scanning module 11.

A first calibration zone or X-directional calibration zone 2 extending in the X direction (lateral direction) is attached to the bottom surface of the document supporting plate 10 for calibration of illumination in the lateral direction, namely the X direction. A second calibration zone or Y-directional calibration zone 4 extending in the Y direction (longitudinal direction) is attached to the bottom surface of the document supporting plate 10 for calibration of illumination in the Y direction. By means of the provision of the second calibration zone 4, a calibration of illumination of the light projected from the frosted plate 38 can be performed to obtain an

excellent scanning result without using diffusion boards employed in the conventional scanner.

Figure 5 shows a flow chart of illumination calibration carried out in accordance with the present invention. The calibration of illumination in the lateral direction is known to those skilled in the art and no further discussion will be given herein. The operation of illumination calibration performed by the flow chart of Figure 5 is mainly for calibration of illumination in the longitudinal direction (Y direction). The operation begins at step 101. The back-light module 3' is provided and activated to generate and project light onto the optical scanning module 11 (step 102). The optical scanning module 11 is then driven to sequentially move from one scan line to the next one in the Y direction or longitudinal direction (step 103). The image sensing elements of the scanning device 1 detect an image signal of each pixel of the second calibration zone 4 when moving in the Y direction and convert and store the optical signal into an electrical representation corresponding to illumination of the pixel (step 104). The storage of the electrical signals can be done with memory means provided in the scanner. If desired, the electrical representation may be taken at a given number of scan lines, such as every five scan lines. That is the optic signal of the pixels is taken every five successive pixels in the longitudinal direction. In case of color scanners, different electrical representation for red, green and blue colors can be taken separately.

In step 105, a preset illumination reference signal is provided, which may be stored in a memory unit of the scanner. Then, the electrical representation of the illumination of selected pixel is compared with the preset illumination reference signal in step 106. The comparison result is then used to evaluate the difference of illumination between two successively-taken pixels that belong to different scan lines and a calibration parameter indicating the difference is obtained based on the difference of illumination (step 106). The parameters are then stored. In case of color scanners, different parameters are obtained for red, green and blue colors of each image pixel.

The stored parameters may be retrieved later to calibrate the

illumination of pixels of an image obtained from a transmissive original document. When an original document is scanned, the illumination of each pixel is obtained through the sensing elements of the image scanning device. The illumination of each pixel is then calibrated with the corresponding parameter that is obtained previously and stored in the memory means (step 107). After each pixel is calibrated with the corresponding parameter, the whole image may then output through suitable output means (step 108).

In brief, the scanner in accordance with the present invention employs a frosted plate to replace the diffusion boards adapted in the conventional scanner. This simplifies the overall structure and reduces the costs. The illumination of each pixel of an image that is being scanned is then calibrated with the corresponding calibration parameter previously obtained to alleviate and even overcome the possible non-uniform distribution of illumination in the longitudinal direction. An excellent quality of image can thus be obtained.

Although the present invention has been described with reference to the preferred embodiment and the best mode of operation thereof, it is apparent to those skilled in the art that a variety of modifications and changes may be made without departing from the scope of the present invention which is intended to be defined by the appended claims.